

## Chromosome number determinations in the Australian Astereae (Asteraceae)

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### ABSTRACT

Chromosome number determinations from 200 populations attributed to 99 species or infraspecific taxa of ten genera are presented in Table I. They include the first substantiated reports for *Brachyscome glandulosa* ( $2n = 36$ ), *B. muellerioides* ( $n = 3$ ), *B. obovata* ( $2n = 18$ ), *B. petrophila* ( $2n = 18$ ), *B. tatei* ( $n = 9$ ), *Erodiocephalum elderi* ( $2n = 16$ ), *Minuria gardneri* ( $n = 9$ ), *M. integrerrima* ( $n = 18$ ), *Olearia astrotricha* ( $n = 9$ ), *O. ferresii* ( $n = 9$ ), *O. imbricata* ( $n = 9$ ), *O. pluchea* ( $n = 9$ ), *O. ramulosa* ( $n = 9$ ), *O. xerophila* ( $n = 9$ ), *Vittadinia cuneata* ( $n = 9$ ), *V. gracilis* ( $n = 9$ ), *V. muelleri* ( $n = 9$ ), *V. pterochaeta* ( $n = 9$ ), *V. pustulata* ( $n = 9$ ) and *V. sulcata* ( $n = 9$ ). Polyploidy is reported for the first time in *Brachyscome dissectifolia*, *B. cardiocarpa*, *Calotis anthemoides* and in the *Olearia phlogopappa* complex. Remaining counts support previously reported determinations and add to the knowledge of chromosome number distribution within taxa. Some taxonomic problems are briefly discussed. It is concluded that chromosomal variation in Australian Astereae is similar to that found in North America.

### Introduction

In a recent census of Australian vascular plants 831 native species of Asteraceae were listed under c. 130 genera (Hnatiuk 1990). About 330 formally recognised species belong to the tribe Astereae, and most are currently distributed amongst four genera, i.e. *Olearia* Moench (c. 130), *Brachyscome* Cass. (c. 70), *Vittadinia* A.Rich. (29) and *Calotis* R.Br. (c. 28). The remaining genera here considered to belong to the Astereae are *Achnophora* F.Muell. (1), *Camptacra* N.T.Burb (2), *Celmisia* Cass. (c. 10), *Centipeda* Lour. (5), *Ceratogyne* Turcz. (1), *Dichrocephala* DC. (1), *Dichromochlamys* Dunlop (1), *Dimorphocoma* F.Muell. & Tate (1), *Elachanthus* F.Muell. (2), *Erigeron* L. (c. 10), *Erodiocephalum* F.Muell. (2), *Eurybiopsis* DC. (1), *Isoetopsis* Turcz. (1), *Ixioclamys* F.Muell. & Sond. (4), *Kippistia* F.Muell. (1), *Minuria* DC. (10 or 11), *Lagenifera* Cass. (4) and *Solenogyne* Cass. (3).

Chromosome number surveys have been primarily restricted to just two genera, i.e. *Brachyscome* (Smith-White *et al.* 1970, Carter 1978, Watanabe & Short 1992) and *Calotis* (Stace 1978, 1982). In this paper we report further chromosome number determinations for both of these genera as well as new determinations for native species of *Erodiocephalum*, *Lagenifera*, *Minuria*, *Olearia*, *Solenogyne* and *Vittadinia*, briefly examine previous reports, and comment on some associated taxonomic problems.

A number of species of Astereae belonging to *Aster* L., *Bellis* L., *Conyza* Less., *Erigeron* L. and *Solidago* L. are naturalised in Australia but with the exception of *Erigeron karvinskianus* they have not been examined.

### Materials and methods

Chromosome counts were obtained from either floral bud material fixed in the field, or from root tips obtained from seedlings grown from fruit of known provenance. For the

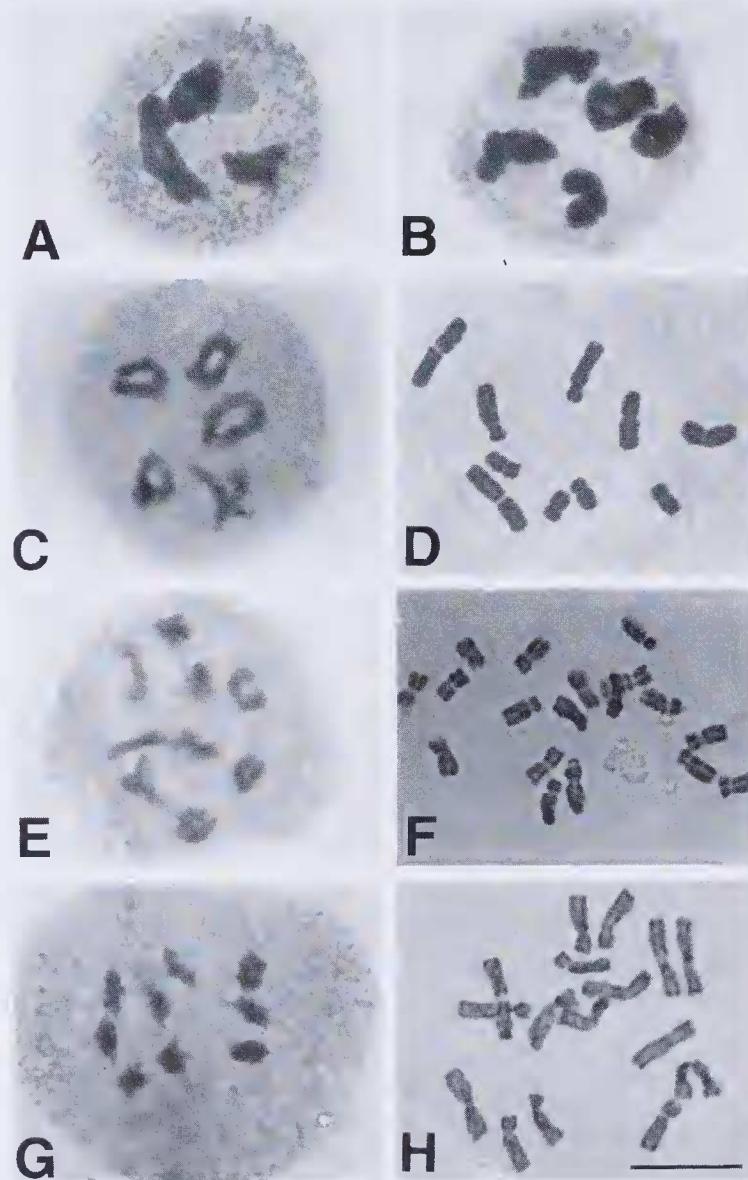


Fig. 1. Mitotic and meiotic chromosomes in Australian Astereae. A - *Brachyscome muellerioides*  $n = 3II$  (Watanabe 3). B - *B. readeri*  $n = 5II$  (Watanabe 4). C - *B.* sp. aff. *nova-anglica*  $n = 5II$  (Short 3969). D - *B.* sp. aff. *angustifolia*  $2n = 10$  (Short 3979). E - *B. tatei*  $n = 9II$  (Watanabe 184). F - *Minuria leptophylla*  $2n = 18$  (Watanabe 194). G - *Vittadinia gracilis*  $n = 9II$  (Short 3925). H - *Erodiocephalum elderi*  $2n = 16$  (Short 3779). Scale: 10  $\mu\text{m}$ .

cultivation of specimens and the preparation of material for chromosome number determinations the procedures of Smith-White *et al.* (1970) and Watanabe *et al.* (1975) were followed. Herbarium vouchers have been gathered for all but two species (*Brachyscome petrophila* and *Olearia ramulosa*) and a complete set of vouchers is housed at MEL. An incomplete set will be deposited in T1 and voucher specimens of non-Victorian populations will be deposited in the major government herbarium (AD, BRI, NSW, PERTH) of the State from which collections were gathered.

## Results

Chromosome number determinations from 200 populations attributed to 99 species or infraspecific taxa of ten genera are presented in Table I. They include the first substantiated reports for *Brachyscome glandulosa* ( $2n = 36$ ), *B. muelleroides* ( $n = 3$ ), *B. obovata* ( $2n = 18$ ), *B. petrophila* ( $2n = 18$ ), *B. tatei* ( $n = 9$ ), *Erodioiphllum elderi* ( $2n = 16$ ), *Minuria gardneri* ( $n = 9$ ), *M. integerrima* ( $n = 18$ ), *Olearia astrotricha* ( $n = 9$ ), *O. ferresii* ( $n = 9$ ), *O. imbricata* ( $n = 9$ ), *O. pluchea* ( $n = 9$ ), *O. ramulosa* ( $n = 9$ ), *O. xerophila* ( $n = 9$ ), *Vittadinia cuneata* ( $n = 9$ ), *V. gracilis* ( $n = 9$ ), *V. muelleri* ( $n = 9$ ), *V. pterochaeta* ( $n = 9$ ), *V. pustulata* ( $n = 9$ ) and *V. sulcata* ( $n = 9$ ). Some reports for apparently distinct, but undescribed, taxa such as *Calotis* aff. *lappulacea* ( $n = 8$ ) and *B. tenuiscapa* aff. var. *tenuiscapa* ( $2n = 28$ ) are also presented, as are new determinations for some previously examined taxa, e.g. *Brachyscome microcarpa* ( $n = 6$ ,  $2n = 12$ ; cf.  $n = 10$  reported by Smith-White *et al.* 1970). Polyploidy is reported for the first time in *Brachyscome dissectifolia*, *B. cardiocarpa*, *Calotis anthemoides* and in the *Olearia phlogopappa* complex and B chromosomes are newly reported in *Brachyscome ciliocarpa*, *B. diversifolia*, *B. iberidifolia*, *B. trachycarpa*, *Minuria leptophylla* and *Olearia pimelioides*.

The meiotic or mitotic chromosomes of some species are displayed in Fig. 1.

The new data is incorporated (by reference to Watanabe *et al.* 1996) in Table II which summarises known chromosome numbers for taxa of Australian Astereae.

## Discussion

As previously pointed out (Watanabe & Short 1992) there are many taxonomic problems within *Brachyscome*. There are unresolved species complexes, e.g. *B. nova-anglica* and its allies and the *B. ciliaris* complex, and generic delimitation is also a problem. The same is true for many of the other genera and the placement of *Isoetopsis* in the Astereae is debatable and perhaps not tenable (Bremer & Anderberg in Bremer 1987, Bruhl & Quinn 1990, Bremer & Humphries 1993). Although there are taxonomic problems it is none the less possible to generally review the state of knowledge of chromosome numbers in the Australian Astereae. An absence of chromosome numbers for some genera, i.e. *Achnophora*, *Camptacra*, *Dichrocephala*, *Dichromochlamys*, *Dimorphocoma* and *Elachanthus* is unfortunate, although between them these genera contain only 12 Australian species.

TABLE 1. NEW CHROMOSOME NUMBER DETERMINATIONS FOR AUSTRALIAN ASTEREAE

Species & locality	n	2n
<i>Brachyscome</i> Cass.		
<i>B. aculeata</i> (Labill.) Less.		
5.5 km SE of Sawyers Hill, Kosciusko N.P., N.S.W., 3 Feb. 1993, Short 3982	9II	
Sawpit Creek, Kosciusko N.P., N.S.W., 4 Feb. 1993, Short 3996	9II	

TABLE 1. CONTINUED

Species & locality	n	2n
6 km from Cathcart toward Rocky Hall, 9 Feb. 1993, N.S.W., <i>Short 4010</i>	9II	
Bundara R. crossing on Omeo to Tallangatta road, Vict., 9 Feb. 1993, <i>Short 4018</i>	18II + 2Bs	
<i>B. sp. aff. angustifolia</i> A. Cunn. ex DC. Mt Kaputar N.P., N.S.W., 28 Jan. 1993, <i>Short 3944</i>	5II	10
Stewart Forest, Barrington Tops State Forest, N.S.W., 1 Feb. 1993, <i>Short 3979</i>	5II	10
Polblue Picnic Site, Barrington Tops State Forest, N.S.W., 1 Feb. 1993, <i>Short 3981</i>		10
<i>B. basaltica</i> F.Muell. var. <i>basaltica</i> 4 km NE of Millmerran, Qld, 29 Sept. 1992, <i>Watanabe 25</i>	8II	16
var. <i>gracilis</i> Benth. 14 km N of Booligal, N.S.W., 6 Sept. 1992, <i>Watanabe 76</i>		12
Barmah State Park, Vict., 23 Sept. 1992, <i>Watanabe 1</i>	6II	
20 km N of Apsley, Vict., 25 Oct. 1993, <i>Watanabe 222</i>	6II	
<i>B. cardiocarpa</i> F.Muell. ex Benth. Digby to Strathdownie road, Vict., 3 Sept. 1990, <i>Short 3919</i>		36
19 km NW of Apsley, Vict., 12 Oct. 1995, <i>Watanabe 306</i>		36
<i>B. cheilocarpa</i> F.Muell. 94 km N of Galena Bridge on NW Coastal Hwy, W.A., 6 Oct. 1993, <i>Short 4083</i>		18
1 km W of NW Coastal Hwy along road to Blowholes, W.A., 7 Oct. 1993, <i>Short 4097</i>		18
<i>B. aff. cheilocarpa (A)</i> Pt Quobba, W.A., 7 Oct. 1993, <i>Short 4091</i>		18

TABLE 1. CONTINUED

Species & locality	n	2n
<b><i>B. aff. cheilocarpa (B)</i></b>		
Cleary to Paynes Find road, W.A., 17 Sept. 1990, <i>Short 3823</i>	9II	
Yalgoo, W.A., 10 Oct. 1993, <i>Short 4108</i>	9II	
<b><i>B. ciliaris</i> (Labill.) Less. complex</b>		
Capc Riche, W.A., 14 Oct. 1993, <i>Short 4126</i>	9II	
Tooreburrup Scenic Lookout, W.A., 14 Oct. 1993, <i>Watanabe 173</i>	9II	
35 km E of Jerramungup, Fitzgerald River Crossing, W.A., 15 Oct. 1993, <i>Watanabe 174</i>	9II	
6 km W of Coolgardie, W.A., 2 Oct. 1993, <i>Watanabe 107</i>	27	
4 km NE of Millmerran, Qld, 29 Sept. 1992, <i>Watanabe 27</i>	27	
52 km SW of Louth, N.S.W., 2 Oct. 1992, <i>Watanabe 47</i>	27	
13 km N of Carnamah, W.A., 5 Oct. 1993, <i>Short 4075</i>	36	
33 km from Blowholes along road to Carnarvon, W.A., 7 Oct. 1993, <i>Short 4094</i>	36	
5 km E of Pindar, W.A., 9 Oct. 1993, <i>Short 4105</i>	36	
27 km from Great Northern Hwy along road to Warriedar Hmsd, W.A., 10 Oct. 1993, <i>Short 4116</i>	36	
63 km W of Balladonia, W.A., 1 Oct. 1993, <i>Watanabe 103</i>	36	
6 km W of Coolgardie, W.A., 2 Oct. 1993, <i>Watanabe 106</i>	36	
12.5 km W of Coolgardie, W.A., 2 Oct. 1993, <i>Watanabe 110</i>	36	
Bonnie Rock, W.A., 11 Oct. 1993, <i>Watanabe 158</i>	36	
E edge of Lake Wallambin, W.A., 11 Oct. 1993, <i>Watanabe 163</i>	36	

TABLE I. CONTINUED

Species & locality	n	2n
25 km NW of Pt Augusta, S.A., 29 Sept. 1993, <i>Watanabe 101</i>	36	
61 km N of Hawker, S.A., 20 Oct. 1993, <i>Watanabe 191</i>	36	
10 km NNE of Ashford, N.S.W., 26 Sept. 1992, <i>Watanabe 15</i>	36	
<i>B. ciliocarpa</i> W. Fitzg. 'The Loop', Murchison River, Kalbarri N.P., W.A., 6 Oct. 1993, <i>Short 4080</i>		18 + 2Bs
40 km from Yalgoo, W.A., 9 Oct. 1993, <i>Short 4107</i>	911	
30 km from Paynes Find along road to Cleary, W.A., 10 Oct. 1993, <i>Short 4119</i>	18	
<i>B. sp. aff. ciliocarpa</i> 41 km E of Quilpic, Qld, 17 Aug. 1989, <i>Short 3607</i>	911	
<i>B. curvicarpa</i> G.L.R.Davis 59.5 km SW of Bourke, N.S.W., 2 Oct. 1992, <i>Watanabe 41</i>	4II + BI	
0.9 km SW of Louth, N.S.W., 2 Oct. 1992, <i>Watanabe 43</i>	4II + BI	
<i>B. debilis</i> Sond. Mt Arapiles, Vict., 25 Oct. 1993, <i>Watanabe 217</i>	3II	6
<i>B. decipiens</i> Hook.f. Sawyers Hill, Kosciusko N.P., N.S.W., 3 Feb. 1993, <i>Short 3986</i>	911	18
<i>B. dentata</i> Gaudich. Dalby, N.S.W., 30 Sept. 1992, <i>Watanabe 29</i>	4II or 4II + BI	
44 km SW of Louth, N.S.W., 2 Oct. 1992, <i>Watanabe 46</i>	4II	
24 km NE of Wirrealpa, N.S.W., 3 Oct. 1992, <i>Watanabe 55</i>	4II	
80 km SE of Broken Hill, N.S.W., 6 Oct. 1992, <i>Watanabe 70</i>	4II + BI	
48 km SE of Martins Well, N.S.W., 3 Oct. 1992, <i>Watanabe 53</i>	8II	

TABLE I. CONTINUED

Species & locality	n	2n
27 km S of Tilpa, N.S.W., 2 Oct. 1992, <i>Watanabe 52</i>	12II	
c. 45 km SE of Broken Hill, N.S.W., 6 Oct. 1992, <i>Watanabe 67</i>	12II	
33 km SW of Broken Hill, N.S.W., 22 Oct. 1993, <i>Watanabe 201</i>	12II	
c. 43 km SE of Broken Hill, N.S.W., 22 Oct. 1993, <i>Watanabe 203</i>	12II	
20 km E of Elmore, Vict., 7 Oct. 1992, <i>Watanabe 77</i>	12II	
<i>B. dissectifolia</i> G.L.R.Davis 3.5 km NW of Backwater, N.S.W., 30 Jan. 1993, <i>Short 3973</i>	12II	24
<i>B. diversifolia</i> (Hook.) Fischer & Meyer 17 km SE of Halls Gap, Vict., 27 Sept. 1993, <i>Watanabe 95</i>	12II	
Polblue Creek, Barrington Tops State Forests, N.S.W., 1 Feb. 1993, <i>Short 3981</i>	18II	36 + 0-1B
<i>B. exilis</i> Sond. Mullett Lake Nature Reserve, near Esperance, W.A., 16 Oct. 1993, <i>Watanabe 178</i>	9II	18
<i>B. formosa</i> P.S.Short 1.6 km SE of Coonabarabran, N.S.W., 24 Sept. 1992, <i>Watanabe 6</i>	9II	
<i>B. glandulosa</i> (Steetz) Benth. Boyagin Rock, W.A., 12 Oct. 1993, <i>Watanabe 165</i>		36
<i>B. gracilis</i> G.L.R. Davis 7.5 km towards Ashford from Bonshaw to Glen Innes road, N.S.W., 29 Jan. 1993, <i>Short 3962</i>		18
<i>B. graminea</i> (Labill.) F.Muell. Sawpit Creek, Kosciusko N.P. N.S.W., 6 Feb. 1993, <i>Short 4008</i>	9II	
Green Cape Lighthouse, N.S.W. 7 Feb. 1993, <i>Short 4015</i>	9II	18
<i>B. halophila</i> P.S.Short 13 km N of Carnamah, W.A., 5 Oct. 1993, <i>Short 4072</i>	9II	

TABLE 1. CONTINUED

Species & locality	n	2n
11 km W of Pindar, W.A., 9 Oct. 1993, <i>Short 4101</i>	9II	
<i>B. iberidifolia</i> Benth. complex Moora, W.A., 4 Oct. 1993, <i>Short 4065</i>	9II	
13 km N of Carnamah, W.A., 5 Oct. 1993, <i>Short 4074</i>		18
2.5 km S of Binnu, W.A., 5 Oct. 1993, <i>Short 4077</i>	9II	
21 km from Carnarvon along road to Gascoyne Junction, W.A., 7 Oct. 1993, <i>Short 4087</i>		18
29 km N of Galena Bridge, W.A., 8 Oct. 1993, <i>Short 4100</i>	9II	
Cosy Corner, W.A., 13 Oct. 1993, <i>Short 4124</i>	9II	
Mt Chudalup, W.A., 13 Oct. 1993, <i>Short 4125</i>	9II or 9II + Bl	
9 km N of Nallan Homestead turn-off along Great Northern Highway, W.A., 26 Aug. 1995, <i>Short 4227</i>	9II	
Cape Leeuwin, W.A., 3 Nov. 1995, <i>Short 4550</i>	9II	
74 km WSW of Coolgardie, W.A., 2 Oct. 1993, <i>Watanabe 111</i>	9II	
Yellowdine, W.A., 2 Oct. 1993, <i>Watanabe 113</i>		9II
c. 5 km NW of Bonnie Rock, W.A., 11 Oct. 1993, <i>Watanabe 161</i>	9II	
Lake Wallanbin, W.A., 11 Oct. 1993, <i>Watanabe 164</i>	9II	
35 km E of Jerramungup, Fitzgerald River crossing, W.A., 15 Oct. 1993, <i>Watanabe 175</i>	9II	
<i>B. latisquamea</i> F. Muell. Pt Quobba, W.A., 7 Oct. 1993, <i>Short 4090</i>		18

TABLE 1. CONTINUED

Species & locality	n	2n
33 km from Blowholes along road to Carnarvon, W.A., 7 Oct. 1993, <i>Short 4093</i>		18
<i>B. liueariloba</i> (DC.) Druec S of Border Village on S.A./W.A. border, 29 Sept. 1993, <i>Watanabe 102</i>		12
12.5 km W of Kimba, S.A., 19 Oct. 1993, <i>Watanabe 187</i>		12
6 km W of Coolgardie, W.A., 2 Oct. 1993, <i>Watanabe 105</i>		16
7 km S of Bimbijy Hmsd turn-off along Paynes Find to Cleary Road, W.A., 10 Oct. 1993, <i>Short 4122</i>		16
33 km from Broken Hill on Menindee road, N.S.W., 22 Oct. 1993, <i>Watanabe 200</i>		16
<i>B. melanoocarpa</i> Sond. & F.Muell 1.4 km W of Menindee, N.S.W., 22 Oct. 1993, <i>Watanabe 209</i>	12II	
<i>B. microcarpa</i> F.Muell. Girraween N.P., Qld, 29 Jan. 1992, <i>Watanabe 80</i>	6II	12
6 km S of Boonoo Boonoo, N.S.W., 30 Jan. 1993, <i>Short 3970</i>	6II	
<i>B. muelleroides</i> G.L.R.Davis Ulupna Island, Vict., 23 Sept. 1992, <i>Watanabe 3</i>	3II	
<i>B. aff. multicaulis</i> F.Muell. 8 km W of Kiandra, N.S.W., 3 Feb. 1993, <i>Short 3988</i>	9II	18 + 0-2Bs
<i>B. multifida</i> DC. complex 3 km S of Glen Alpin, Qld, 30 Jan. 1993, <i>Short 3965</i>	7II	
Warrumbungles N.P., N.S.W., 25 Sept. 1992, <i>Watanabe 7</i>	7II	
Mt Kaputar N.P., N.S.W., 25 Sept. 1992, <i>Watanabe 11</i>	7II	14
Nr Clover Flat along Big River Fire Track, Vict., 9 Feb. 1993, <i>Short 4021</i>	9II	18

TABLE 1. CONTINUED

Species & locality	n	2n
1.2 km NW of MacKenzie Falls, Vict., 27 Sept. 1993, <i>Watanabe 97</i>	9II	
<b><i>B. nivalis</i> F.Muell.</b> Club Lake, Mt Kosciusko N.P., N.S.W., 5 Feb. 1993, <i>Short 4005</i>	11III	22
<b><i>B. nodosa</i> P.S.Short &amp; K.Watan.</b> Bracket Creek, Qld, 29 Sept. 1992, <i>Watanabe 19</i>	3II	
15.5 km E of Inglewood, Qld, 29 Sept. 1992, <i>Watanabe 20</i>	3II	
2 km E of Inglewood, Qld, 29 Sept. 1992, <i>Watanabe 24</i>	3II	
69 km N of Coonabarabran, N.S.W., 25 Sept. 1992, <i>Watanabe 8</i>	3II	
<b><i>B. nova-anglica</i> G.L.R.Davis</b> Girraween N.P., Qld, 29 Jan. 1993, <i>Watanabe 79</i>	7II	14
26.5 km SE of Wongwibinda, N.S.W., 31 Jan. 1993, <i>Short 3978</i>	7II	14
<b><i>B. aff. nova-anglica (A)</i></b> 3 km S of Glen Aplin, Qld, 30 Jan. 1993, <i>Short 3969</i>	5II	10
<b><i>B. aff. nova-anglica (B)</i></b> Mt Kaputar N.P., N.S.W., 25 Sept. 1992, <i>Watanabe 9</i>	6II	12
<b><i>B. obovata</i> G.L.R.Davis</b> Daners Gap, Mt Kosciusko N.P. N.S.W., 4 Feb. 1993, <i>Short 3993</i>		18
Blue Lake to Charlotte Pass Mt Kosciusko N.P., N.S.W., 5 Feb. 1993, <i>Short 3997</i>		18
Mustering Flat, Baw Baw Plateau, Vict., 26 Feb. 1991, <i>Walsh 3051</i>		18
<b><i>B. oncocarpa</i> Diels</b> 100 km N of Galena Bridge on NW Coastal Hwy, W.A., 6 Oct. 1993, <i>Short 4084</i>		18

TABLE 1. CONTINUED

Species & locality	n	2n
<i>B. papillosa</i> G.L.R.Davis 28.7 km S of Ivanhoe, N.S.W., 6 Oct. 1992, <i>Watanabe 73</i>	4II or 4II + 1B	
Muggabah Creek, 14 km N of Booligal, N.S.W., 6 Oct. 1992, <i>Watanabe 75</i>		8
<i>B. perpusilla</i> (Steetz) J.M.Black Totadgin Rock, W.A., 3 Oct. 1993, <i>Watanabe 115</i>		18
Bonnie Rock, W.A., 11 Oct. 1993, <i>Watanabe 160</i>		18
<i>B. petrophila</i> G.L.R.Davis Angler's Rest, Vict. Unvouchered colln, Feb. 1993		18
<i>B. procumbens</i> G.L.R.Davis Mt Kaputar N.P., N.S.W., 28 Jan. 1993, <i>Short 3951</i>		18
<i>B. ptychocarpa</i> F.Muell. Mt Mittamatite Regional Park, Vict., 3 Dec. 1993, <i>Short 4151</i>	6II	12
<i>B. pusilla</i> Steetz W edge of Lake King, W.A., 1 Nov. 1995, <i>Short 4533</i>	9II	
<i>B. radicans</i> Steetz ex Lehm. Mother of Ducks Nature Reserve, Guyra, N.S.W., 31 Jan. 1993, <i>Short 3976</i>	13II	26
<i>B. readeri</i> G.L.R.Davis Ulupna Island, Vict., 23 Sept. 1992, <i>Watanabe 4</i>	5II	10
<i>B. rigidula</i> (DC.) G.L.R.Davis Lake Omeo, c. 0.4 km S of intersection of Blowhard road and Lake Omeo road, Vict., 9 Feb. 1993, <i>Short 4016</i>	9II	18
<i>B. scapigera</i> (Sieber ex Sprengel) DC. 3.5 km NW of Backwater, N.S.W., 30 Jan. 1993, <i>Short 3972</i>	9II	18
Buckety Plains, Bogong N.P., Vict., 9 Feb. 1993, <i>Short 4023</i>	9II	
<i>B. smithwnitei</i> P.S.Short & K.Watan. 28.7 km S of Ivanhoe, N.S.W., 6 Oct. 1992, <i>Watanabe 72</i>	6II or 3IV	

TABLE 1. CONTINUED

Species & locality	n	2n
1.4 km W of Menindee, N.S.W., 22 Oct. 1993, <i>Watanabe 210</i>	6II or 3IV	
<i>B. spathulata</i> Gaudich. Sawyers Hill, Kosciusko N.P., N.S.W., 3 Feb. 1993, <i>Short 3985</i>	27II	
Daners Gap, Kosciusko N.P., N.S.W., 4 Feb. 1993, <i>Short 3994</i>	27II	
Club Lake, Kosciusko N.P., N.S.W., 5 Feb. 1993, <i>Short 4003</i>	9II	18
Cathcart to Rocky Hall, N.S.W., 6 Feb. 1993, <i>Short 4011</i>	27II	
<i>B. stolonifera</i> G.L.R.Davis Club Lake, Kosciusko N.P., N.S.W., 5 Feb. 1993, <i>Short 4006</i>	15II	30
<i>B. stuartii</i> Benth. Girraween N.P., Qld, 29 Jan. 1993, <i>Watanabe 81</i>	6II	12
11 km from Deepwater towards Tenterfield, N.S.W., 29 Jan. 1993, <i>Short 3964</i>	6II	
<i>B. tatei</i> J.M.Black 42.5 km E of Border Village, S.A., 18 Oct. 1993, <i>Watanabe 184</i>	9II	18
<i>B. tenuiscapa</i> Hook.f. var. <i>pubescens</i> (Benth.) G.L.R.Davis 3.5 km NW of Backwater, N.S.W., 30 Jan. 1993, <i>Short 3975</i>	9II	
aff. var. <i>tenuiscapa</i> 3.5 km NE of Mt Reynard, Snowy Plains, Vict., <i>Walsh s.n.</i> , Cultivated RBG, Accession No. 905484		28
<i>B. trachycarpa</i> F.Muell. Ceduna, S.A., 12 Sept. 1990, <i>Short 3781</i>	18 + 0-2Bs	
<i>B. sp. aff. trachycarpa</i> F.Muell. 25 km W of Dalby, N.S.W., 30 Sept. 1992, <i>Watanabe 31</i>	27I or III + 0-9II + 1s	
<i>Brachyscome</i> sp. 8 km NW of Glendambo, S.A., 26 Aug. 1989, <i>Short 3673</i>	9II	

TABLE 1. CONTINUED

Species & locality	n	2n
119 km N of Glendambo, S.A., 26 Aug. 1989, <i>Short 3682</i>	9II	
<b><i>Calotis</i> R.Br.</b>		
<b><i>C. authemoides</i> F.Muell.</b>	14II	
Ulupna Is., Vict. 26 Sept. 1993, <i>Watanabe 92</i>		
<b><i>C. cuueata</i> (F.Muell. ex Benth.) G.L.R.Davis</b>		
var. <i>cuueata</i>		
25 km W of Dalby, N.S.W., 30 Sept. 1992, <i>Watanabe 32</i>	16II	
<b><i>C. cuueifolia</i> R.Br.</b>		
17 km SW of Dubbo, N.S.W. 24 Sept. 1992, <i>Watanabe 5</i>	8II	16
15.5 km E of Inglewood, Qld, 29 Sept. 1992, <i>Watanabe 23</i>	8II	
20 km E of Elmore, Vict., 7 Oct. 1992, <i>Watanabe 78</i>	8II	
25 km W of Dalby, N.S.W., 30 Sept. 1992, <i>Watanabe 34</i>	16II	
<b><i>C. cymbacantha</i> F.Muell.</b>		
Tilpa, N.S.W., 2 Oct. 1992, <i>Watanabe 48</i>	14II	
<b><i>C. deutex</i> R.Br.</b>		
3 km S of Glen Alpin, Qld, 30 Jan. 1993, <i>Short 3967</i>	8II	16
<b><i>C. erinacea</i> Steetz</b>		
15 km SW of Kimba, S.A., 21 Sept. 1982, <i>Short 1766</i>	I2II + IIV	
<b><i>C. lappulacea</i> Benth.</b>		
15.5 km E of Inglewood, Qld, 29 Sept. 1992, <i>Watanabe 21</i>	14II	
<b><i>C. aff. lappulacea</i></b>		
15.5 km E of Inglewood, Qld, 29 Sept. 1992, <i>Watanabe 22</i>	8II	
<b><i>C. multicaulis</i> (Turcz.) Druce</b>		
38 km N of Pt Augusta, S.A., 5 Oct. 1992, <i>Watanabe 62</i>	4II	
<b><i>C. plumulifera</i> F.Muell.</b>		
24 km NE of Wirrealpa, S.A., 4 Oct. 1992, <i>Watanabe 56</i>	5II + BII	

TABLE 1. CONTINUED

Species & locality	n	2n
72 km S of Charleville, Qld, 1 Oct. 1992, <i>Watanabe</i> 38		5II + BII
45 km SE of Broken Hill, N.S.W., 6 Oct. 1992, <i>Watanabe</i> 66		5II + 2BI
80 km SW of Broken Hill, N.S.W., 6 Oct. 1992, <i>Watanabe</i> 69		5II + 2BI
<i>C. scabiosifolia</i> Sond. & F.Muell var. <i>scabiosifolia</i> 15 km SW of Louth, N.S.W., 2 Oct. 1992, <i>Watanabe</i> 45	8II	
28.7 km S of Ivanhoe, N.S.W., 23 Oct. 1993, <i>Watanabe</i> 213	8II	
Sawpit Creek, Kosciusko N.P., N.S.W., 4 Feb. 1993, <i>Short</i> 3995	16II	
<i>C. scapigera</i> Hook. Louth, N.S.W., 2 Oct. 1992, <i>Watanabe</i> 42	8II	
6 km NE of Jerilderie, N.S.W., 26 Jan. 1993, <i>Short</i> 3933	16II	
<i>Erigeron</i> L.		
<i>E. karvinskianus</i> DC. 4 km N of Mt Slide, Vict., March 1991, <i>H.Manson</i> s.n., (MEL 1592608)	36	
<i>Erodiophyllum</i> F.Muell.		
<i>E. elderi</i> F.Muell. 41 Km ENE of Iron Knob, S.A., 12 Oct. 1990, <i>Short</i> 3779	16	
<i>Kippistia</i> F.Muell.		
<i>K. suaedifolia</i> F.Muell. Lake Austin, W.A., 25 Aug. 1995, <i>Short</i> 4221	9II	
<i>Lagenifera</i> Cass.		
<i>L. huegellii</i> Benth. 4 km N of Zumstein, Grampians, Vict., 26 Oct. 1993, <i>Watanabe</i> 225	18	
<i>L. stipitata</i> (Labill.) Druce Mt Kaputar N.P., N.S.W. 28 Jan. 1993 <i>Short</i> 3952	9II	18
Barton Tops State Forests, N.S.W., 1 Feb. 1993, <i>Short</i> 3980		18

TABLE I. CONTINUED

Species & locality	n	2n
<b>Minuria DC.</b>		
<i>M. cunninghamii</i> (DC.) Benth. Lake Austin, W.A., 25 Aug. 1995 <i>Short 4223</i>	9II	
Tilpa, N.S.W., 2 Oct. 1992 <i>Watanabe 49</i>	9II	
<i>M. gardneri</i> Lander & R. Barry Lake Austin, W.A., 25 Aug. 1995, <i>Short 4222</i>	9II	
<i>M. integriflora</i> (DC.) Benth. Dalby, N.S.W., 30 Sept. 1992, <i>Watanabe 30</i>	18II	
28 km W of Condamine, N.S.W., 30 Sept. 1992, <i>Watanabe 35</i>	18II	
0.9 km SW of Louth, N.S.W. 2 Oct. 1992, <i>Watanabe 44</i>	18II	
<i>M. leptophylla</i> DC. Wudinna Hill, S.A., 19 Oct. 1993, <i>Watanabe 186</i>	9II	
28.5 km N of Orroroo, S.A., 21 Oct. 1993, <i>Watanabe 194</i>	9II	18 + 0-2Bs
<b>Olearia Moench</b>		
<i>O. astrotricha</i> (F.Muell.) F.Muell. ex Benth. Victoria Range road, Grampians, Vict., 2 Dec. 1986, <i>Corrick 10103</i>	9II	
<i>O. ciliata</i> (Benth.) F.Muell. ex Benth. 10 km SE of Ravensthorpe, W.A., 3 Sept. 1986, <i>Short 2663</i>	9II	
Between Karkoo and Mount Hill, S.A., 29 Sept. 1993, <i>Watanabe 100</i>	9II	
<i>O. ferresii</i> (F.Muell.) F.Muell. ex Benth. S. boundary of Ormiston Gorge N.P., N.T., 12 Aug. 1988, <i>Short 3148</i>	9II	
<i>O. humilis</i> Lander Sandstone to Yuinmery, W.A., 14 Oct. 1986, <i>Short 2563</i>	9II	
Yuinmery, W.A., 14 Oct. 1986, <i>Short 2565</i>	9II	

TABLE 1. CONTINUED

Species & locality	n	2n
<i>O. inubricata</i> (Turcz.) Benth. 10 km SE of Ravensthorpe, W.A., 3 Sept. 1986, <i>Short 2662</i>	9II	
<i>O. phlogopappa</i> (Labill.) DC. complex Falls Creek, Vict., 2 March 1987 <i>Short 3035</i>	18II	
<i>O. pinuelioides</i> (DC.) Benth. 53.5 km E of 'Nallan', W.A., 1986, <i>Lander 1391</i>	9II	
Sandstone-Paynes Find road, W.A., 24 Aug. 1986, <i>Short 2564</i>	9II	
Parachilna to Blinman road, S.A., 20 Oct. 1993, <i>Watanabe 193</i>		18 + 2Bs
<i>O. plucheacea</i> Lander Kennedy Range, W.A., 20 Aug. 1986, <i>Short 2535</i>	9II	
<i>O. rauulosa</i> (Labill.) Benth. complex Golton Gorge, Grampians, Vict. 11 Sept. 1986, <i>RBG 86/1735</i>	9II	
<i>O. ruddis</i> (Benth.) Benth. 19 km SW of Three Springs, W.A., 9 Sept. 1986, <i>Short 2795</i>	9II	
10 km S of Mt Hope, N.S.W., 16 Sept. 1987, <i>Short 3078</i>	9II	
17 km N of Patchewollock, Vict., 25 Aug. 1988, <i>Short 3174</i>	9II	
<i>O. stuartii</i> (F.Muell.) Benth. Kennedy Range, W.A., 20 Aug. 1986 <i>Short 2538</i>	9II	
<i>O. xerophila</i> (F.Muell.) Benth. Dales Gorge, W.A., 30 Aug. 1995, <i>Short 4275</i>	9II	
<i>Olearia</i> sp. 23.6 km N of Maroubra Rd/Scotsman Rd intersection, W.A., 1986, <i>Lander 1408</i>	9II	
<i>Solenogyne</i> Cass. <i>S. douinii</i> L.G.Adams Ulupna Island, Vict., 25 Jan. 1993, <i>Short 3923</i>	I8	

TABLE I. CONTINUED

Species & locality	n	2n
<b>Vittadinia</b> A.Rich. <i>V. cuneata</i> DC. var. <i>hirsuta</i> N.T.Burb. 4 km NE of Milmerran, Qld, 29 Sept. 1992, Watanabe 26	9II	18
<i>V. gracilis</i> (Hook.f.) N.T.Burb. 2 km W of Hines Hill, W.A., 23 Oct. 1995, Short 4450	9II	
Ulupna Island, Vict., 25 Jan. 1993, Short 3925	9II	
<i>V. muelleri</i> N.T.Burb. 44 km NE of Narrabri, N.S.W., 26 Sept. 1992, Watanabe 14	9II	
<i>V. pterochaeta</i> (F.Muell. ex Benth.) J.M.Black 24 km NE of Wirrealpa, S.A., 3 Oct. 1992, Watanabe 57	9II	
<i>V. pustulata</i> N.T.Burb. 28 km W of Condamine, N.S.W., 30 Sept. 1992, Watanabe 36	9II	
<i>V. sulcata</i> N.T.Burb. c. 10 km S. of Wild Dog Glen, S.A., 20 Oct. 1993, Watanabe 190	9II	

## BRACHYSCOME

As in Watanabe & Short (1992) our references to species and species complexes in Tables I & II are largely the concepts of Davis (1948, 1949, 1955, 1959) and Smith-White *et al.* (1970) although the concept of 'superspecies' is not used. As we are primarily concerned here with the presentation of new chromosome number determinations and with reviewing chromosome numbers in the Australian Astereae, further comments on species or generic delimitation are here kept to a minimum. Such problems will be the subject of future papers and will follow after the completion of detailed anatomical, morphological, cytological and macromolecular studies.

As currently recognised *Brachyscome* is a genus of more than 80 species and occurs in Australia, New Guinea and New Zealand. Of these, over 70 species are confined to Australia. Davis (1948) recognised two subgenera within *Brachyscome*, i.e. '*Eubrachyscome*' and '*Metabrachyscome*'. They are illegitimate names but are frequently adopted in cytological papers (e.g. Smith-White *et al.* 1970).

The majority of species were referred by Davis to 'subgenus *Eubrachyscome*' and this group was the subject of cytological investigations by Smith-White *et al.* (1970). They found an array of chromosome numbers in the group and suggested that it represents a reducing series, i.e.  $x = 9$  to  $x = 2$ . It was also noted that most species with  $n = 9$  (including polyploids) are mesic, perennial species. In contrast, species of arid regions frequently display an annual habit and this is correlated with lower chromosome numbers. Chromosome number determinations by Watanabe & Short (1992), and in this paper for species not examined by Smith-White *et al.*, are consistent with these observations. Thus *B. goniocarpa* ( $n = 4$ ), *B. gracilis* ( $n = 4$ ), *B. muelleri* ( $n = 3$ ) and *B. muelleroides* ( $n = 3$ ) are all annual species which occur in arid, or seasonally dry areas.

As noted by Carter (1978a), species referred by Davis to 'subgenus *Metabrachyscome*' are chromosomally conservative compared to members of '*Eubrachyscome*'. All species have  $x = 9$ , with polyploidy mainly confined to the *B. ciliaris* complex. Many of the species are also annuals confined to arid regions.

The *B. iberidifolia* complex referred to in both Tables is mainly confined to Western Australia and includes *B. bellidioides* and *B. pusilla*. The complex belongs to 'subgenus *Metabrachyscome*'. There is considerable diversity in collections referred by us to this complex and additional taxa undoubtedly should be recognised.

The chromosome complements of *B. nivalis* ( $2n = 22$ ), *B. radicans* ( $2n = 26$ ), *B. tenuiscapa* aff. var. *tenuiscapa* ( $2n = 28$ ) and *B. stolonifera* ( $2n = 30$ ) are markedly different from those found in most other species, their karyotypes displaying two different sizes of chromosomes. This is in marked contrast to the unimodal karyotypes found in species with  $2n = 18$ . However, species with chromosome numbers less than  $2n = 18$  frequently have bimodal karyotypes, a feature explained by descending aneuploidy caused by reciprocal translocation and loss of centromeric fragments. Species with chromosome numbers greater than  $2n = 18$  are perhaps amphidiploids originating as a result of hybridization between taxa with chromosome numbers less than  $n = 9$ .

Both the array of chromosome numbers and the discrepancies in numbers reported by us with those published by Smith-White *et al.* (1970) for *B. diversifolia*, *B. microcarpa*, *B. multifida* and *B. nova-anglica* may in part be the result of misidentification. However, they primarily reflect the morphological complexity of the taxa concerned. More work is required to clarify the delimitation of the various entities in these complexes and therefore discussion of the significance of chromosome numbers in these taxa is premature.

#### CALOTIS

A genus containing 28 formally recognised species *Calotis* mainly occurs in semi-arid and arid regions of Australia.

Stace (1978, 1982) has reported on the cytoevolution of the genus and noted two significant trends, i.e. a reduction from a base of  $x = 8$  down to  $x = 4$  in the mainly arid zone annuals, and a high degree of polyploidy. Two-thirds of the species were found to be polyploids and this condition was found to be as frequent in low chromosome number annuals as in high chromosome number perennials.

Our data presented in Table I support the observations made by Stace.

#### CELMISIA

*Celmisia* contains about 70 species confined to Australia and New Zealand. They are mainly found in alpine regions and most are endemic to New Zealand, only about ten species occurring in Australia. Celmisias are perennial herbs or subshrubs of diverse habit and a cytological survey of 65 species (Hair 1980, Given & Gray 1986) indicates that most are at least 12-ploid, with  $n = 54$ . Haploid numbers of  $n = 54$  and  $n = 108$  have been found in Australian species.

#### CERATOZYNE

*Ceratogyne obionoides*, the only member of this genus, is an annual species with  $n = 6$  and is found throughout much of arid Australia.

#### ERODIOPHYLLUM

A ditypic genus, *Erodiophyllum* occurs in semi-arid and arid mainland Australia. Both species are perennial herbs with  $n = 8$ .

TABLE II. SUMMARY OF CHROMOSOME NUMBER DETERMINATIONS IN NATIVE AUSTRALIAN ASTEREAE

	n	2n	
<b>Brachyscome</b> Cass.			
<i>B. aculeata</i> (Labill.) Cass. ex Lessing	9,18 0-6Bs	18	Stace 1981; Watanabe <i>et al.</i> 1996
<i>B. aff. aculeata</i> (Mt Gingera)	9 + 1B		Stace 1981
<i>B. aff. aculeata</i> (Halls Gap)	27		Stace 1981
<i>B. angustifolia</i> A.Cunn.ex DC. var. <i>angustifolia</i>	9		Smith-White <i>et al.</i> 1970
var. <i>heterophylla</i> (Benth.) G.L.R.Davis	9		Smith-White <i>et al.</i> 1970
<i>B. sp. aff. angustifolia</i>	5	10	Watanabe <i>et al.</i> 1996
<i>B. basaltica</i> F.Muell. var. <i>basaltica</i>	8	16	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
var. <i>gracilis</i> Benth.	6	12	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B. breviscapis</i> C.R.Carter	4	8	De Jong 1963; Smith- White <i>et al.</i> 1970; Carter 1978c; Watanabe & Short 1992
<i>B. campylocarpa</i> J.M.Black	5	10	Smith-White <i>et al.</i> 1970, as 'B. campylocarpa' sp. B', Watanabe & Short 1992
<i>B. cardiocarpa</i> F.Muell. ex Benth.	9	36	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. cheilocarpa</i> F.Muell.	9		Carter 1978a; Watanabe <i>et al.</i> 1996
<i>B. aff. cheilocarpa</i> (A)		18	Watanabe <i>et al.</i> 1996
<i>B. aff. cheilocarpa</i> (B)	9		Watanabe <i>et al.</i> 1996
<i>B. chrysoglossa</i> F.Muell.	4	8 + 0-3Bs	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
<i>B. ciliaris</i> (Labill.) Less. complex	9,18 27, 36I	27,36 81	De Jong 1963; Smith- White <i>et al.</i> 1970; Carter 1978a; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996

TABLE II. CONTINUED

	<b>n</b>	<b>2n</b>	
<i>B. ciliocarpa</i> W.Fitzg.	9	18 + 0-2Bs	Carter 1978a; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B.</i> sp. aff. <i>ciliocarpa</i>	9		Watanabe <i>et al.</i> 1996
<i>B. cuneifolia</i> Tate	9	18	Stace 1981
<i>B. curvicarpa</i> G.L.R.Davis	4	8 + 0-5Bs	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B. debilis</i> Sond.	3	6	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B. decipiens</i> Hook.f.	9,27	18,54	Solbrig <i>et al.</i> 1964; Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. dentata</i> Gaudich.	4,8,12 + 0-4Bs	8,16 24 + 0-4Bs	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B. dichromosomatica</i> C.R.Carter	2 + 0-3Bs + micro Bs	4 + 0-3Bs +micro Bs	Smith-White 1968, as <i>B. lineariloba</i> ; Smith-White <i>et al.</i> 1970, as 'B. <i>lineariloba</i> sp. A'; Smith-White & Carter 1970, as 'B. <i>lineariloba</i> sp. A'; Watanabe <i>et al.</i> 1975, as 'B. <i>lineariloba</i> race A'; Carter 1978b; Carter 1978c; Smith-White & Carter 1981; Nagl & Pfeifer 1988; Watanabe <i>et al.</i> 1991; Watanabe & Short 1992
<i>B. dissectifolia</i> G.L.R.Davis	6,12	12,24	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. diversifolia</i> (Hook.) Fischer & C. Meyer var. <i>diversifolia</i>	12,16 18,c.20	24, 36 + 0-1B	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996

TABLE II. CONTINUED

	n	2n	
<i>B. eriogona</i> (J.M.Black) G.L.R.Davis	4	8	Smith-White <i>et al.</i> 1970, as 'B. <i>campylocarpa</i> sp. A'; Watanabe & Short 1992
<i>B. exilis</i> Sond.	9	18	Carter 1978a; Watanabe <i>et al.</i> 1996
<i>B. formosa</i> P.S.Short	9		Short 1988; Watanabe <i>et al.</i> 1996
<i>B. glandulosa</i> (Steetz) Benth.		36	Watanabe <i>et al.</i> 1996
<i>B. goniocarpa</i> Sond. & F.Muell.	4	8	Watanabe <i>et al.</i> 1991; Watanabe & Short 1992
<i>B. gracilis</i> G.L.R.Davis	4	8	Smith-White <i>et al.</i> 1970, as <i>B.</i> <i>diversifolia</i> var. <i>dissecta</i> G.L.R. Davis; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B. graininea</i> (Labill.) F.Muell.	9	18	Smith-White <i>et al.</i> 1970; Watanabe <i>et</i> <i>al.</i> 1996
<i>B. halophila</i> P.S.Short	9	18	Short 1988; Watanabe & Short 1992; Watanabe <i>et</i> <i>al.</i> 1996
<i>B. iberidifolia</i> Benth.	9 + 0-1B	18	De Jong 1963; Chouksanova <i>et al.</i> 1968; Gupta 1969; Turner 1970, including specimens referred to <i>B.</i> <i>bellidioides</i> ; Carter 1978a; Keighery 1978; Gupta & Gill 1983, 1989; Watanabe <i>et</i> <i>al.</i> 1996
<i>B. latisquamea</i> F.Muell.	9	18	Carter 1978a; Watanabe <i>et al.</i> 1996
<i>B. leptocarpa</i> F.Muell.	3	6	Smith-White <i>et al.</i> 1970, probably

TABLE II. CONTINUED

	n	2n	
			conspecific with <i>B. debilis</i>
<i>B. lineariloba</i> (DC.) Druce	6,8 4II + 2I	10,12 16	Smith-White 1968; Smith-White <i>et al.</i> 1970; Carter & Smith-White 1972; Kyhos <i>et al.</i> 1977; Watanabe <i>et al.</i> 1985; Watanabe & Smith-White 1987; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996; Watanabe <i>et al.</i> 1996
<i>B. lyrifolia</i> J.M.Black	9	18	Smith-White <i>et al.</i> 1970 and Carter 1978, as to Parachila collections of <i>B. ciliaris</i> ; Watanabe & Short 1992
<i>B. melanocarpa</i> Sond. & F.Muell.	6,12	12,30	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B. microcarpa</i> F.Muell.	6, 10 10II + 4I	12	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. muelleri</i> Sond.	3	6	Watanabe & Short 1992
<i>B. muelleroides</i> G.L.R.Davis	3	6	Watanabe <i>et al.</i> 1996
<i>B. multicanlis</i> F.Muell.	9	18	Watanabe & Short 1992, as <i>B. rigidula</i>
<i>B. aff. multicanlis</i>	9	18 + 0-2Bs	Watanabe <i>et al.</i> 1996
<i>B. multifida</i> DC. complex	7,9	14,18	Smith-White <i>et al.</i> 1970, including var. <i>dilatata</i> Benth. and var. <i>multifida</i> ; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B. nivalis</i> F.Muell.	11	22	Smith-White <i>et al.</i> 1970, excluding record of n = 9, re Stace 1981; Watanabe <i>et al.</i> 1996

TABLE II. CONTINUED

	<b>n</b>	<b>2n</b>	
<i>B. nodosa</i> P.S.Short & K.Watan.	3	6	Smith-White <i>et al.</i> 1970, as 'B. <i>goniocarpa</i> '; Watanabe & Short 1992, as 'B. sp. aff. <i>goniocarpa</i> '; Short & Watanabe 1993; Watanabe <i>et al.</i> 1996
<i>B. nova-anglica</i> G.L.R.Davis	7	14	Smith-White <i>et al.</i> 1970, a count of 3n = 18 is probably erroneous; Watanabe <i>et al.</i> 1996
<i>B. aff. nova-anglica (A)</i>	5	10	Watanabe <i>et al.</i> 1996
<i>B. aff. nova-anglica (B)</i>	6	12	Smith-White <i>et al.</i> 1970, as <i>B. nova-anglica</i> ; Watanabe <i>et al.</i> 1996
<i>B. obovata</i> G.L.R.Davis		18	Watanabe <i>et al.</i> 1996
<i>B. oncocarpa</i> Diels	9	18	Carter 1978a; Watanabe <i>et al.</i> 1996
<i>B. papillosa</i> G.L.R. Davis	4 + 0-2Bs	8	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. parvula</i> Hook.f.	9		Smith-White <i>et al.</i> 1970; Carter 1978a
<i>B. perpusilla</i> (Steetz) J.M.Black	9	18,36	Smith-White <i>et al.</i> 1970; Carter 1978a; Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B. petrophila</i> G.L.R. Davis		18	Watanabe <i>et al.</i> 1996
<i>B. procumbens</i> G.L.R.Davis	9	18	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. ptychocarpa</i> F.Muell.	6	12	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. pusilla</i> Steetz	9	18	Carter 1978a; Watanabe <i>et al.</i> 1996

TABLE II. CONTINUED

	n	2n	
<i>B. radicans</i> Steetz	13	26	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. rara</i> G.L.R. Davis	6	12	Watanabe & Short 1992
<i>B. readeri</i> G.L.R. Davis	5	10	Watanabe & Short 1992; Watanabe <i>et al.</i> 1996
<i>B. rigidula</i> (DC.) G.L.R. Davis	9	18	?Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. riparia</i> G.L.R. Davis	9		Watanabe & Short 1992
<i>B. scapigera</i> (Sprengel) DC.	9	18	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. sieberi</i> DC. var. <i>gummii</i> DC.	9 + 0-1B		Stace 1981
<i>B. smithwhitei</i> P.S. Short & K. Watan.	3,6	6,12 + 0-2Bs	Smith-White <i>et al.</i> 1970, as 'B. campylocarpa sp. C'; Watanabe & Short 1992, as 'B. sp. aff. <i>campylocarpa</i> '; Short & Watanabe 1993; Watanabe <i>et al.</i> 1996
<i>B. spathulata</i> Gaudich. subsp. <i>glabra</i> (DC.) Stace	9	18	Stace 1981
subsp. <i>spathulata</i>	9,18,27 36,45		Stace 1981; Watanabe <i>et al.</i> 1996
<i>B. stolonifera</i> G.L.R. Davis	15	30	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. stuartii</i> Benth.	6	12	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<i>B. tatei</i> J.M. Black	9	18	Watanabe <i>et al.</i> 1996
<i>B. tenuiscapa</i> Hook.f. var. <i>pubescens</i> (Benth.) G.L.R. Davis	9	18	Smith-White <i>et al.</i>

TABLE II. CONTINUED

	<b>n</b>	<b>2n</b>	
			1970; Watanabe <i>et al.</i> 1996
<i>aff. var. tenniscapa</i>		28	Watanabe <i>et al.</i> 1996
<i>B. tesquorum</i> J.M.Black	9	18	Smith-White <i>et al.</i> 1970
<i>B. tetrapterocarpa</i> G.L.R. Davis	4 + 0-1B	8	Watanabe & Short 1992
<i>B. trachycarpa</i> F.Muell.	27	18 + 0-2Bs, 36	De Jong 1963; Carter 1978a; Watanabe <i>et al.</i> 1996
<i>B. sp. aff. trachycarpa</i>	271 or 1III + 0-9II + 1s		Watanabe <i>et al.</i> 1996
<i>B. uliginosa</i> G.L.R.Davis	9		Smith-White <i>et al.</i> 1970
<i>B. whitei</i> G.L.R.Davis	5	10	Smith-White <i>et al.</i> 1970; Watanabe & Short 1992
<i>Brachyscome</i> sp.	9		Watanabe <i>et al.</i> 1996, referred to <i>B. iberidifolia</i> , Fl. S. Aust.
<i>Calotis</i> R.Br.			
<i>C. ancyrocarpa</i> J.M.Black	4	8	Stace 1978
<i>C. anthemoides</i> F.Muell.	7,14	14	Solbrig <i>et al.</i> 1964; Stace 1978; Watanabe <i>et al.</i> 1996
<i>C. cneata</i> (F.Muell. ex Benth.) G.L.R.Davis	16	32 + 0-10Bs	Stace 1978; Watanabe <i>et al.</i> 1996
<i>C. cuneifolia</i> R.Br.	8,16	16,32	Solbrig <i>et al.</i> 1964; Stace 1978; Watanabe <i>et al.</i> 1996
<i>C. cymbacantha</i> F.Muell.	7,14	28	Stace 1978; Watanabe <i>et al.</i> 1996
<i>C. dentex</i> R.Br.	8	16	Stace 1978; Watanabe <i>et al.</i> 1996

TABLE II. CONTINUED

	<b>n</b>	<b>2n</b>	
<i>C. eriaceae</i> Steetz	7,14 21,28	14,28 56	Turner 1970; Stace 1978; Watanabe <i>et al.</i> 1996
<i>C. glandulosa</i> F.Muell.	8	16	Stace 1978
<i>C. hispidula</i> (F.Muell.) F. Muell.		16	Stace 1978
<i>C. intermis</i> Maiden & Betche	8	16	Stace 1978
<i>C. lappulacea</i> Benth.	14		Stace 1978; Watanabe <i>et al.</i> 1996
<i>C. ? aff. lappulacea</i>	8		Watanabe <i>et al.</i> 1996
<i>C. latinscula</i> F.Muell. & Tate	7,14 28	14,21	Stace 1978, 1982
<i>C. multicaulis</i> (Turcz.) Druce	4,8	8,16	Turner 1970; Stace 1978, as <i>C.</i> <i>multicaulis</i> sp. B; Watanabe <i>et al.</i> 1996
<i>C. plumulifera</i> F.Muell.	5 + 02Bs	10,20	Stace 1978, as <i>C. multicaulis</i> sp. B; Watanabe <i>et al.</i> 1996
<i>C. porphyroglossa</i> F. Muell.	10	20	Stace 1978
<i>C. scabiosifolia</i> Sond. & F.Muell. var. <i>integrifolia</i> F.Muell. ex Benth.	8,16	16,32	Stace 1978
var. <i>scabiosifolia</i>	8,16	16,32	Stace 1978; Watanabe <i>et al.</i> 1996
<i>C. scapigera</i> Hook.	8,16		Stace 1982; Watanabe <i>et al.</i> 1996
<i>C. squamigera</i> C.T.White		16	Stace 1978
<i>C. xanthosoidea</i> Domin	8	16	Stace 1978
<i>Celmisia</i> Cass.			
<i>C. asteliifolia</i> Hook.f. complex	54 108	108 216	Hair 1980
<i>C. longifolia</i> Cass. complex	54 108	108	Hair 1980
<i>C. sericophylla</i> J.H.Willis		108	Hair 1980
<i>Ceratogyne</i> Turcz.			
<i>C. obionoides</i> Turcz.	6		Turner 1970

TABLE II. CONTINUED

	<b>n</b>	<b>2n</b>	
<b>Erodiophyllum</b> F.Muell.			
<i>E. acanthocephalum</i> Stapf	8		Solbrig <i>et al.</i> 1964
<i>E. elderi</i> F.Muell.		16	Watanabe <i>et al.</i> 1996
<b>Isoetopsis</b> Turcz.			
<i>I. graminifolia</i> Turcz.	17		Turner 1970
<b>Kippistia</b> F.Muell.			
<i>K. suaedifolia</i> F.Muell.	9		Short 1986; Watanabe <i>et al.</i> 1996
<b>Lagenifera</b> Cass.			
<i>L. huegelii</i> Benth.	9	18	Turner 1970; Watanabe <i>et al.</i> 1996
<i>L. stipitata</i> (Labill.) Druce	9	18	Smith-White <i>et al.</i> 1970; Watanabe <i>et al.</i> 1996
<b>Minuria</b> DC.			
<i>M. cunninghamii</i> (DC.) Benth.	9	18	Turner 1970; Watanabe <i>et al.</i> 1996
<i>M. gardneri</i> Lander & R.Barry	9		Watanabe <i>et al.</i> 1996
<i>M. integerrima</i> (DC.) Benth.	18		Watanabe <i>et al.</i> 1996
<i>M. leptophylla</i> DC	9	18 + 0-2Bs	Turner 1970; Short Watanabe <i>et al.</i> 1996
<b>Olearia</b> Moench			
<i>O. adenolasia</i> F.Muell.	9		Turner 1970
<i>O. algida</i> N.A.Wakef.		18	Beuzenberg & Hair 1984
<i>O. argophylla</i> F.Muell.	54		Solbrig <i>et al.</i> 1964
<i>O. astroloba</i> Lander & N.G.Walsh	9		Short in Lander & Walsh 1989
<i>O. astrotricha</i> (F.Muell.) F.Muell. ex Benth.	9		Watanabe <i>et al.</i> 1996
<i>O. axillaris</i> (DC.) F.Muell. ex Benth.	9		Solbrig <i>et al.</i> 1964
<i>O. ciliata</i> (Benth.) F.Muell. ex Benth.	9		Turner 1970; Watanabe <i>et al.</i> 1996
<i>O. ferresii</i> (F.Muell.) F.Muell. ex Benth.	9		Watanabe <i>et al.</i> 1996

TABLE II. CONTINUED

	n	2n	
<i>O. floribunda</i> (Hook.f.) Benth.	9		Pai 1964
<i>O. frostii</i> (F.Muell.) J.H.Willis		18	Beuzenberg & Hair 1984
<i>O. humilis</i> Lander	9		Turner 1970, as <i>Olearia</i> sp.; Short in Lander 1989; Watanabe <i>et al.</i> 1996
<i>O. imbricata</i> (Turcz.) Benth.	9		Watanabe <i>et al.</i> 1996
<i>O. muelleri</i> (Sond.) Benth.	9		Turner 1970
<i>O. pannosa</i> Hook.		90	Beuzenberg & Hair 1984
<i>O. phlogopappa</i> (Labill.) DC. complex	9,18		Solbrig <i>et al.</i> 1964; Watanabe <i>et al.</i> 1996
<i>O. pimeleoides</i> (DC.) Benth.	9	18 + 0-2Bs	Turner 1970, and as <i>O. propinqua</i> ; Watanabe <i>et al.</i> 1996
<i>O. plucheacea</i> Lander	9		Short in Lander 1990; Watanabe <i>et al.</i> 1996
<i>O. ramulosa</i> (Labill.) Benth. complex	9		Watanabe <i>et al.</i> 1996
<i>O. rufis</i> (Benth.) Benth.	9		Turner 1970; Watanabe <i>et al.</i> 1996
<i>O. stuartii</i> (F.Muell.) F.Muell. ex Benth	9		Short in Lander 1989; Watanabe <i>et al.</i> 1996.
<i>O. xerophila</i> (F.Muell.) Benth.	9		Watanabe <i>et al.</i> 1996
<i>Olearia</i> sp.	9		Watanabe <i>et al.</i> 1996, syn. <i>Eurybia dampieri</i> DC.
<i>Solenogyne</i> Cass.			
<i>S. bellidiooides</i> Cass.	9		Smith-White <i>et al.</i> 1970; Adams 1979
<i>S. dominii</i> L.G.Adams	9	18	Adams 1979; Watanabe <i>et al.</i> 1996
<i>S. gunnii</i> (Hook.f.) Cabrera	9		Adams 1979
<i>Vittadinia</i> A.Rich.			
<i>V. cuneata</i> DC.			

TABLE II. CONTINUED

	<b>n</b>	<b>2n</b>	
<i>var. hirsuta</i> N.T.Burb.	9	18	Watanabe <i>et al.</i> 1996
<i>V. dissecta</i> (Benth.) N.T.Burb.			
<i>var. hirta</i> N.T.Burb.	9		Turner 1970, as <i>V. triloba</i> & <i>Vittadinia</i> sp.
<i>V. gracilis</i> (Hook.f.) N.T.Burb.	9		Watanabe <i>et al.</i> 1996
<i>V. muelleri</i> N.T.Burb.	9		Watanabe <i>et al.</i> 1996
<i>V. pterochaeta</i> (F.Muell. ex benth.) J.M.Black	9		Watanabe <i>et al.</i> 1996
<i>V. pustulata</i> N.T.Burb.	9		Watanabe <i>et al.</i> 1996
<i>V. sulcata</i> N.T.Burb.	9		Watanabe <i>et al.</i> 1996

## ERIGERON

Given (1973) and Given & Gray (1986) noted that Australian species of *Erigeron* should be excluded from that genus. Nesom (1994a,b) has subsequently referred most Australian species to three genera, i.e. *Iotasperma* Nesom, *Lagenithrix* Nesom and *Pappochroma* Labill. (syn. *Lagenopappus* Nesom), but has left the placement of *E. conyzoides* F.Muell. unresolved. Cladistic studies (by PSS) in Australian Astereae do not wholly support Nesom's treatment and will be the subject of a future paper.

The alpine *E. pappochroma* complex (*Lagenithrix* & *Pappochroma* sensu Nesom) seemingly has affinities with the *Olearia-Celmisia* complex (Given & Gray 1986) and could be expected to have a base of  $x = 9$ .

The count of  $2n = 36$  for the introduced *E. karvinskianus* is consistent with those obtained by Montgomery & Yang (1960, as *E. mucronatus* DC.).

## LAGENIFERA &amp; SOLENOGYNE

Whether or not *Solenogyne* is deserving of generic rank or should be relegated to synonymy under *Lagenifera* has been the subject of debate for some years (Drury 1974, Adams 1979). They are here maintained as separate genera pending further work. All species are perennials and tend to be found in mesic conditions. Our chromosome number determinations, i.e.  $n = 9$  and  $2n = 18$ , are consistent with the observations of previous workers (Smith-White *et al.* 1970, Turner 1970, Adams 1979).

## KIPPISTIA &amp; MINURIA

Eleven species are currently placed in this genus (Lander & Barry 1980b, Lander 1987b, Short 1991) although one, *M. macrorhiza*, should possibly be reinstated as *Eurybiopsis* (see below). All but one, *M. annua* (Tate) J.M.Black, are apparently perennial herbs or small shrubs although several, including *M. multiseta* P.S.Short may be short lived. We have confirmed earlier reports of  $n = 9$  for *M. cunninghamii* and *M. leptophylla* (Turner 1970, Short 1986) and here record the tetraploid condition for *M. integerrima*. The presence of B chromosomes is here reported for the first time in this genus.

*Kippistia*, a monotypic genus, at one time relegated to synonymy under *Minuria* but reinstated by Lander & Barry (1980a), is seemingly very closely related to the latter genus. *K. suaedifolia* is a small shrub with  $n = 9$ .

## OLEARIA

*Olearia* consists of about 180 species and occurs in Australia, New Guinea and New Zealand. About 130 species occur in Australia (Lander 1992) and the genus is currently under revision. All species are shrubs and the genus is widespread in alpine, temperate and arid regions of Australia. Few species have been cytologically examined but our data are consistent with the finding for New Zealand species that the base number is  $x = 9$ . However, most Australian species are diploids, a contrast to the situation in New Zealand where only 12-, 14-, 32- and 48-ploid levels have been recorded (Beuzenberg & Hair 1984). For the first time B chromosomes are also reported for this genus, having been observed by us in *O. pimelioides*.

## VITTADINIA, CAMPTACRA &amp; EURYBIOPSIS

Burbidge (1982) revised *Vittadinia* and recognised 29 species, most of which are confined to Australia. She segregated two further genera, describing ditypic *Camptacra* (Lander 1987b) and reinstating monotypic *Eurybiopsis*. Lander (1987a) has subsequently reduced *Eurybiopsis* to synonymy under *Minuria* although more recent work by Wiggins (1990) suggests that the former genus should be maintained.

Chromosome counts are lacking for *Camptacra* and *Eurybiopsis* and until now for all but one species of *Vittadinia*. Chromosome numbers are now known for seven species (Table II). Of these, three are, or possibly are, annuals. All seven species have  $n = 9$ . One of these is more or less confined to temperate areas, the others extend from temperate to arid areas.

## Base numbers and comparisons

With the exception of *Isoetopsis*, which possibly should be placed in the Gnaphalieae (Bremer & Humphries 1993), ditypic *Erodiophyllum*, monotypic *Ceratogyne*, and the essentially arid-zone genus *Calotis*, all Australian genera for which data are available have one or more species with  $n = 9$  or a base number that is a multiple of 9. Therefore, it seems reasonable to conclude that  $x = 9$  is the base number for the Australian Astereae, a conclusion that is in keeping with previous findings for the tribe Astereae (Raven *et al.* 1960, Solbrig *et al.* 1964, 1969). Following a survey of mainly Northern Hemisphere genera (38 out of 53) and some Southern Hemisphere genera (22 out of 65) Solbrig *et al.* (1964) also noted that many species with low chromosome numbers ( $n = 4$  & 5) belong to mainly annual genera that are concentrated in southwestern North America and that low numbers were probably correlated with dry habitats. As noted above, the same correlations are apparent in annual species of *Brachyscome* 'subgenus *Eubrachyscome*', *Calotis* and *Ceratogyne*. Chromosomal variation in Australian Astereae is clearly similar to that found in North America. In fact, although fewer chromosome number determinations were available to him, Turner (1970) previously suggested this to be the case, not just for the tribe Astereae, but the entire family.

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